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Technology Progress in the Chinese Construction Industry under the Iron-Fist of Government[†]

Government policies and actions in transitional economies have far-reaching consequences for technology progress. Many studies suggest the important role of governments in providing policies and finance to facilitate technology innovations. The Chinese government has often been seen to exemplify this. This article probes government actions in practice, the way it is conducted and the negative consequences for innovation. We focus on one of China's most important and successful sectors – construction. An analytical framework based on “complex systems industry” is used and a causal map developed to examine the role of the Chinese government acting as client, regulator and administrator of industrial and professional bodies and their impact on innovation in the construction sector. This paper confirms that innovation is industry specific and social and economic context dependent. While recognising the powerful role of the Chinese government, it argues that in reality the “Chinese government” is not a uniform entity, but rather consists of various entities acting in accordance with their varied vested interests at a specific time and under particular circumstances.

KEY WORDS: Transition economies, China, construction industry, technology progress, complex systems industry.

Introduction

China's construction sector has overtaken the U.S.A.'s for the first time to become the world number one: and by 2010 it is forecast to account for a fifth of the world's building industry (Hammond and Anderlini, 2011). Paradoxically, however, its uptake of new technology has been extremely slow. How do governments impact on organizations and management has now stimulated

[†] The authors wish to acknowledge, with appreciation, detailed and helpful comments from Sally Stewart, former Visiting Professor University of the South Pacific and Head of the Department of Management Studies at the University of Hong Kong.

much wider interest (Jones, 2001): and the field has been galvanized by Ring, Bigley, D'Aunno, & Khanna's (2005) Special Issue of the Academy of Management, by which this paper was inspired.

Probing government influence and the mechanisms by which governments affect organizations and industries potentially extends our theoretical understanding of their impact on industrial technology progress. Lessons drawn may also inspire policy makers and organization managers, bringing about necessary changes in policy and practices.

Much literature that addresses this issue sees the rationales for government interventions and examines the effective means utilised by governments. For example, Salmenkaita and Salo (2002) examine the reasons why governments intervene in industrial technology progress. Schoening et al. (1998); King and Nowack (2003); Lu and Lazonick (2001), summarize methods adopted by certain governments to intervene in industrial technology progress. Our research examines the practices of government bodies in the construction industry, acting as clients, regulator and in various cases an administrator. This study puts their roles in the analysis of innovation and examines their consequences.

By applying an analytical framework of complex systems industry (Miller et al. 1995) to China's construction industry, this paper discusses the Chinese government involvement in two possible system innovation models. In one, government bodies are often clients of construction projects, acting as Gardiner and Rothwell (1985) and von Hippel (1988) suggest to be tough customers (users) that may compel the adoption of new technologies in the industry. In the other, government bodies acting as regulator working with industrial and professional bodies, which set technical standards / criteria thus demanding innovation to achieve the quality/ safety improvements of construction projects (Winch et al. 2007). From the technology studies tradition, we treat innovation as activities and processes embedding social, economic and political elements in a specific context where the innovation takes place. This paper discusses in particular institutional structure of innovation in the Chinese construction industry and analyse the role of different government bodies in promoting or rather hindering the adoption of new technologies.

This paper is based on a research project, for which we were commissioned by the construction bureau of the Zhejiang provincial government. In Zhejiang province, the industrial output of the construction sector has been ranked No.1 in the country since 2000. Our project was the outcome of the provincial government initiatives, after the national survey on the Chinese Construction Industry Reform and Development (the report was published in 2008) conducted by the Centre for Policy Research (CPR), Ministry of Housing and Urban-Rural Development (MOHURD) and the Department of Engineering Quality and Safety Supervision (DEQSS), which reveals the slow progress in technology in the sector.

The project was undertaken over a period of two years starting from May 2007. Built on top of the report (see above) and economic statistics and other secondary data, our primary data was collected through dedicated discussion workshops and semi-structured face-to-face interviews. Four workshops were held, each with participation of government officials from relevant departments and representatives from construction firms. Additional three interviews were carried out for gaining further information needed. Seven major construction firms in the province took part. Other participants include stakeholders such as Construction Administration Bureau and Construction Industry association in Zhejiang province.

The influence of governments in transition economies

Jone (2001) highlights two barriers to studying the influence of governments on organization and management. First, it is hard to separate the influence of government from such factors as individual assumptions and expectations; historic inertia; non-governmental institutions and other variables. Second, theories revealing the mechanisms by which governments influence management; organizations and organizational behaviour are scarce, as in the West, governments are generally remote from organizational decision making and action. Research interest has, however, emerged in recent years as highlighted in a Special Issue of Academy of Management Review in 2005 (Ring et al. 2005). Several papers focused on the question of how governments matter, and explored the extent to which government action facilitates economic development and industry creation (Spencer

et al. 2005); the effect of corrupt governments on decision making by managers in multinational corporations (Rodriguez et al. 2005); the concept of political market attractiveness and its role on firm strategy (Bonardi et al. 2005) and how government deregulation influences firm performance through corporate governance mechanisms (Bongjin and Prescott, 2005). Ring et al. (2005) also identify two avenues for future research: one treating governmental impact as a context; another focusing on the organization of governments and its effects.

The influence of governments in transition economies, as those in particular transforming from centrally planned to market economies, is more direct and complex (Hoskisson et al. 2000): and the business system is deeply embedded in government arenas. Krug and Hendrichske (2008) observed that the diversity of Chinese business systems reflects the co-evolution of institutional change in local governments and in business sectors. Although many empirical studies of transition economies, for example China, found the level of government ties is related positively to firm performance (Tan et. al. 2007), while others see the hindrances of the state interferences. However, most studies focus on government policies, and many treat government as a uniform entity.

The roles of government in industrial technology progress

From a theoretical perspective, Salmenkaita and Salo (2002) argue that during the process of commercializing new technology, government intervention can mitigate market and system failure; eliminate structural rigidity, or respond to participant myopia – thus contributing to industrial technology progress. For example, to mitigate market failure, a government could support university research; to mitigate system failure, a government could fund joint projects conducted by universities and industries; to eliminate structural rigidity, governments could provide public venture capital; to respond to participant myopia, governments could create joint decision making between government, industry and university.

Developed and developing countries differ in terms of such government intervention practices. Schoening et al. (1998) compared the influence of science and technology policies adopted by governments in United States, Britain, Taiwan and Korea on 86 new products developed (NPD) by

firms. They found that in the U.S. and Britain, governments' policies had little direct effect on NPD activities in private sectors. In contrast, governments in Korea and Taiwan played dominant roles in promoting new products and innovation activities through, for example, tax credits; direct and indirect grants; low interest loans and intellectual property regulations. Japan's industrial technology progress also evidences some effects of government intervention as in, for example, the aircraft industry (King and Nowack, 2003). Many case studies in China demonstrate that government has played crucial role in promoting technology development and deployment by acting as an integrator bringing together players in the entire supply chain (Stewart et al. 2011 and Lu and Lazonick, 2001).

However governments intervene in multiple ways, which sometimes inconsistently because of different vested interests involved with individual participating government departments. The relationship between government officials and the managers of private firm can prove cooperative and positive (Tjosvold et al. 2008); but state direct intervention in corporate governance can also exert negative effects (Victor et al. 2007). Caerteling et al. (2008) found that the behaviour of government as regulators and sponsors conflict with their roles as buyers.

Whilst government intervention effect on industrial technology progress are complex, most extant literature does not investigate systematically into the inconsistency of government policies in general and actions specifically conducted by individual departments / divisions in different administrative levels

Complex systems industry

The notion of a complex systems industry was systemically introduced by Miller et al. (1995) based on a study of innovation in the flight simulator industry. Their paper draws particular attention to the diversity of innovation of products and services in terms of institutional structures embedded in these processes. They differentiate flight simulators; telecommunications exchanges; military systems; airplanes; chemical process plants and heavy electrical equipment, as complex systems, from those governing, e.g. mass produced goods, on which Schumpeterian model is based.

According to Miller et al. (1995), “complex systems are large item, customised, engineering intensive goods which are seldom, if ever, mass produced” (p364). Davies and Hobday (2005) point out complex products and systems (CoPS) are often organised on a project basis. Because of the nature of these projects which are to meet the customers demands, “the innovation idea often originates with the customer (Davies and Hobday 2005: p9)

Winch (1998) further applied the analytical framework of complex systems industry to construction industry. Building on an analysis of major characteristics of construction products (immobility, complexity, durability, costliness, and high degree of social responsibility) by Nam and Tatum (1988), Winch argue that construction products/services are complex product systems. Thus, the construction industry could be considered a complex systems industry. Based on the early studies of innovation in EU and US construction industries by Quigley, Allen, Margirier and Gann et al., Winch recognized that the construction industry had several unique characteristics, which are different from the model of complex systems industry developed by Miller et al. (1995). There were two system integrators in the construction industry: general architecture/engineer and general contractor, one at the design stage, and the other at the construction stage. Due to the different actors involved in the process at different stages, also the fragmentation in profession with specialised technologies and knowledge inputs, no single existing organisation can act as innovation brokers (see Figure 1).

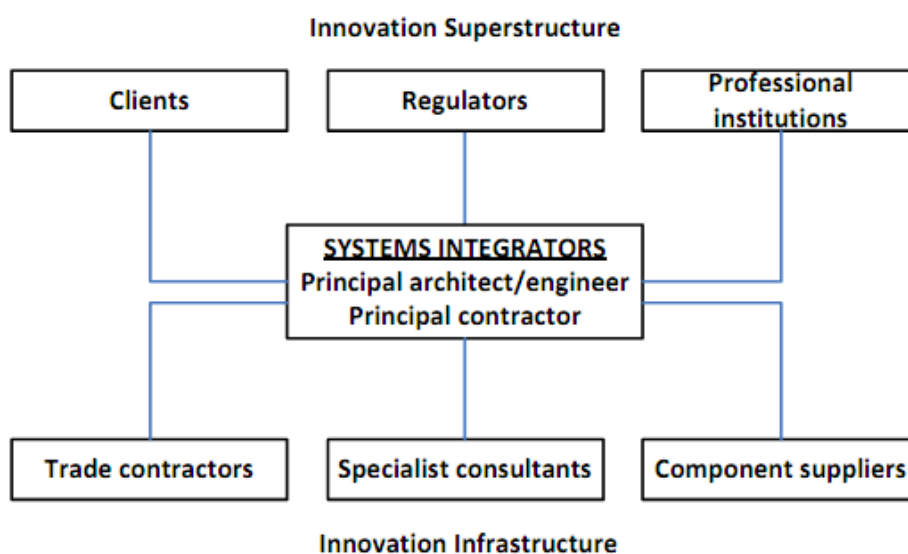


Figure 1. Construction as a complex systems industry (Winch 1998: 270)

He identified the “innovation superstructure” in construction sector consisting of three actors, clients, regulators and professional institutions. They are not directly involved in developing/designing and adopting new technologies, however play crucial roles which could either promote by coordinating and prosecuting or hinder innovation. In construction project processes, innovations are often driven by particular client needs, for example, demanding for new types of buildings and/or problem solving stemming from a specific building sites, etc. Regulators may also set new requirements and standards which may push firms to adopt new technologies, although regulatory system is often cited as a major source of problems and obstacles for individual firms to adopt new technology due to perhaps stringent safety requirements (Winch 1998). Industrial associations and professional bodies can assist the regulator in setting up technical standards, as well as provide a platform for knowledge and information exchanges (Miller 1995).

Winch and Courtney (2007) further suggest a not-for-profit organisation to be established to undertake an intermediary role acting as innovation broker and driving technology progress within a complex systems industry like construction. Their definition of innovation brokers is of “typically as a public-private partnership” and will be able to carry out “the independent validation of new ideas”, which thus facilitate the adoption of new technologies and ideas in construction projects. Many of the organisations classified as such an innovation broker require government support, for example, with funding for researches. However, even their empirical studies display that the types of partnership and institutions which do play a positive role in innovation differ in different social contexts. The paper does not clarify how “independency” can be obtained by these organisations.

Slow Technology Progress in the Chinese Construction Industry

Following the foundation of the People’s Republic of China and before its economic reforms opening up to the outside world at the end of the 1970s, the creative contribution of the construction industry to the national economy was largely under-evaluated. According to the economic classification based on the Soviet model adopted by the then socialist government, the construction

industry was not an independent substantial production sector: neither a *primary* nor a *secondary industry* producing goods. After April 2, 1980, when Deng Xiaoping gave his speech on the industry, the development direction of the industry has, however, changed. Deng Xiaoping pointed out: “Viewed from major capitalist countries, construction industry is one of three pillars in national economies...the construction industry has to be addressed in long-term planning” (Fan 2008:85). Deng Xiaoping’s speech paved the way for the reform and development of the construction industry. Consequently, the industry entered a most vigorous development stage. Figure 2 shows the gross output value of the Chinese construction industry between 1980- 2007. During this period, it has grown from RMB28.6 billion to RMB5104.3 billion, at an average annual rate of 21%, much higher than the overall GDP growth rate.

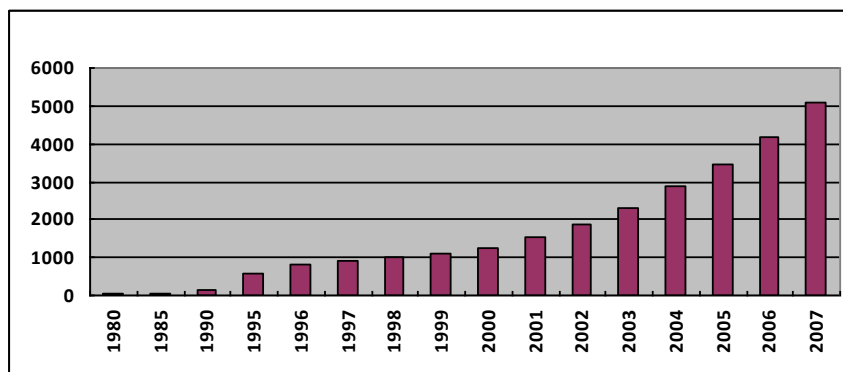


Figure 2. Gross output value of the Chinese construction industry (in billion RMB yuan): 1980-2007.

Source: China Statistical Yearbook on Construction, 2008.

In spite of such rapid growth, statistics show the contribution rate of science and technology to the industry is less than 15%, which is much lower than other industries and the overall economy (40%) (You, 2005), labour productivity (see Figure 3) has been low and showing little improvement during that period. Some believe this problem is attributable to meagre science and technology input (see Figure 4).

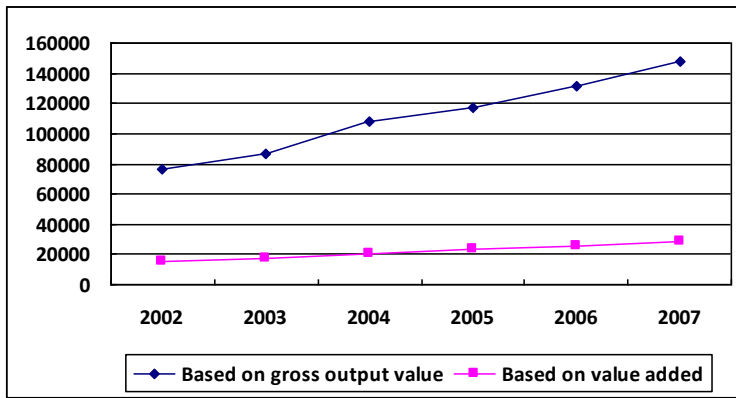


Figure 3. Labor productivity in the Chinese construction industry (in RMB yuan): 2002-2007.

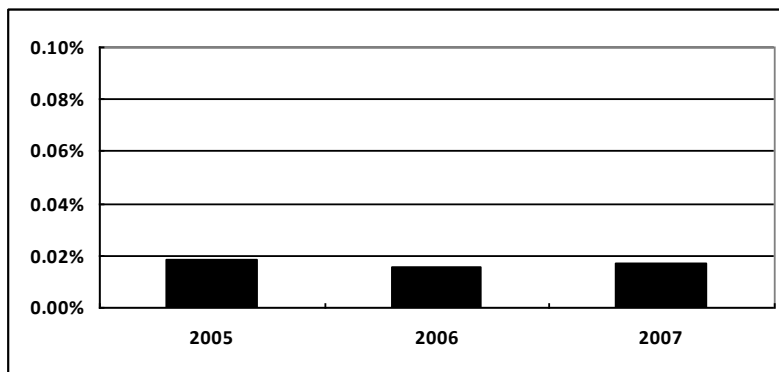


Figure 4. Share of science and technology expenditure in overall output value.

Source: China Statistical Yearbook on Construction, 2008;

Many see the slow technological progress due to China's socialist tradition which created a gap between architect design and building works for construction projects. Project designs are carried out by professionals in design institutions, whereas building works done by labour-intensive construction firms. After the economic reforms, many Chinese scholars and practitioners in the sector called for reforming the old institutional structure to an integrated design-build system (CPR and DEQSS, 2008), which is also endorsed by the government. However, the CPR's survey (see above) of construction firms shows only a very limited number of Chinese construction firms, merely largest ones, have experimented with such an integrated design-build system. This has been seen by Chinese scholars and practitioners as a typical symptom of the industry lacking incentives and momentum for taking up any new innovative approaches and ideas.

The Role of Governments in Chinese Construction Industry

To adapt Winch's model to the Chinese construction industry, we see that the key actors in the innovation infrastructure consist of sub-constructors and material and equipment suppliers and in the innovation superstructure there are clients, regulators, industrial association and professional institutions. As described earlier, although in principle the principal architect/engineer and principal contractor are supposed to share the role as systems integrators, in the Chinese system, the power may go elsewhere. For example, the client of individual projects might well be powerful taking the control in the selecting of systems integrators, interpreting of regulatory requirements and mobilising of professional bodies and industrial associations especially when government bodies are the client. Apart from that, in China, principal contractors often lack the knowledge of available new technologies and sometimes incentives to utilise them. Whereas compared to them, design institutes are more well-informed about new technologies (Xu et al. 2004). However during the project processes, the control and management are largely in the hands of the former. The reasons for that are apparent, because it is extremely crucial for principal contractors to take the full and absolute responsibility for the quality and safety of the project throughout of the whole process at every routine procedure. In China's environment, the rapid increase of the demands in construction sector has attracted a huge number of migrant populations, who are cheap labour however not necessarily experienced. In addition to this, inexperienced and greedy owner of these private companies may make things even worse.

Before the economic reform, all building contractors were state-owned. All construction companies which undertook infrastructural building projects were under the direct control of government departments at national, provincial and municipal levels or within individual industries' hierarchical administration. The economic reforms have opened up the construction market for competition. Private companies have been playing increasing role in the sector. Those stronger players can also be the contractors for large building projects including infrastructural projects offered by government bodies. *The Conducting Ideals on Cultivating and Developing General-*

contract and Project-management Enterprises issued by the Chinese government in 2003 states all the enterprises with survey and design qualification or building general contractors qualification could undertake general contracting within the registered business scope.

In the environment where public slogans of the governing bodies are “getting rich is glorious (*zhifu guangrong* in Chinese)”, “reforming leads to material prosperity (*gaige zhifu*)”, professional ethics may well give way to motives for sheer profit creation. Material and equipment suppliers are not isolated from such an environment. There have been numerous media reports about the substandard of the construction projects due to those unethical and greedy suppliers.

The reality in the Chinese construction industry and the broader social and economic context make the innovation in this project oriented complex systems industry become even more complex. In such an environment, only the Chinese government has an overarching power over the innovation superstructure and has direct and indirect links with the key players. In many cases, government bodies are not only clients, but also regulators and administrators of key professional bodies.

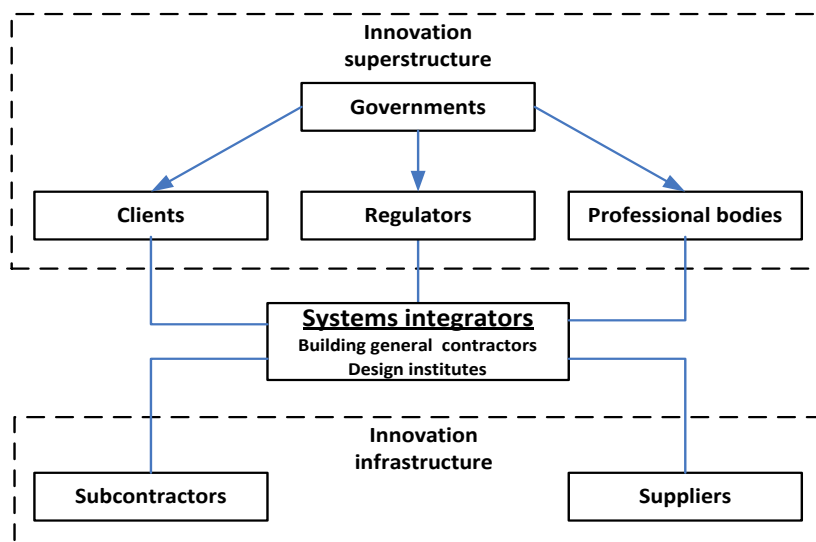


Figure 5. Chinese construction industry as a complex systems industry.

Governments as clients

After the economic reforms, private real estate developers have emerged and share with the players from public sectors as the clients in the construction market. The public clients include governments, public institutions and State-Owned Enterprises (SOEs). Because government departments, at various levels, are investing in construction projects to provide public facilities, they also become clients.

No doubt, in the last three decades, the public sector has been by and large the main client in the China's construction market. Our data collected does not give a precise figure about the share of the government invested projects. We can still estimate on the basis of the fixed capital investment by ownership types and the total fixed capital investment which are used to substitute for those data in the construction industry.¹ Further, assuming that government investment is equivalent to state owned investment, the share of government investing projects can be estimated indirectly. Figure 6 shows the share of state owned versus private fixed capital investment in the total fixed capital investment.² Although the share of state owned investment has been falling, it still retains a lead over the private sector. These data indicate that government construction investments, where they are clients, still account for a high proportion of the total.

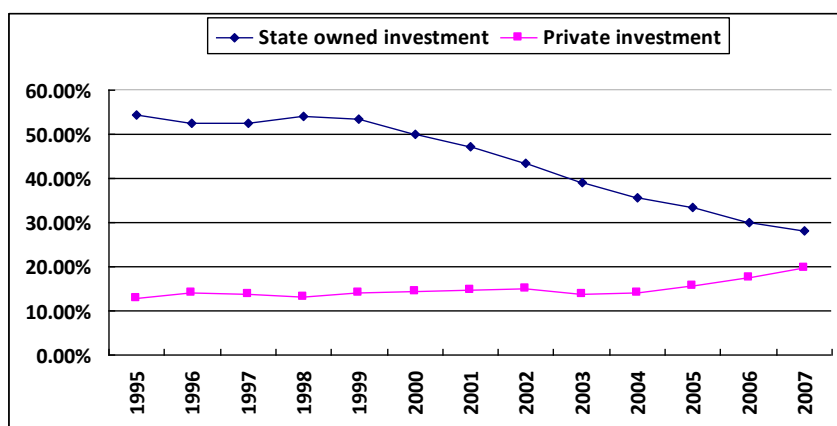


Figure 6. Fixed capital investment by ownership types: 1995-2007

Source: China Statistical Yearbook, 2008

The Construction Law of the People's Republic of China issued in 1997 stipulates: “The contract issuing unit of a construction project may award in total the contract of surveying, design, construction and equipment procurement of the construction project to a general contracting unit of the project. It may also award one item or several items of surveying, design, construction and equipment procurement of the construction project to a general contracting unit of the project”. The second sentence allows clients to make decisions on selection of surveying, design, construction and equipment procurement. Under such a law, clients are more powerful than either general contractors or design institutions. As clients government departments are thus afforded excessive power influencing any uptake of new technology. Clearly the Chinese government could easily be the vital player of even single handed acting as innovation broker in the construction sector to promote uptakes of new technologies and ideas for whatever goals. The general policies of the government have been openly, explicitly and rigorously promoting innovation, manifesting not only in S and T policies but also other industrial policies and the policies for trade, taxation, etc. (Shen 1999, Stewart et al. 2011).

Albeit, as a client of building projects, a specific government department, may not necessarily following the above guiding principles by the central government. A policy which is supported by some government institutions may be disregarded by other government bodies. For example, the government authority in the construction industry encourages an integrated design – build system, while in practice, “most of the governmental clients do not even know the new system nor the significant benefits of the integrated design/build system” (CPR and DEQSS, 2008). Even the same government organisation may advocate or be non-supportive for the same policy in different circumstances for different projects.

For any organisation having a construction project at hand, deciding bid outcomes entails enormous power to the project management team/personel. The extent of the power increases with the scope of the construction project. Handing over an entire project to someone else, e.g. to a general construction company with an integrated design/build system means giving the power away.

This is not something many institutions/individuals like to do, in particular when personal benefits are involved. Even though accepting the advantages of the integrated design-build system (see above), many government clients confirm that they are not willing to let the power of controlling the project go elsewhere easily for the sake of the recommendations by either professional bodies, general constructor or other governments (CPR and DEQSS 2008). Particularly in the current Chinese system many individuals and groups involved can use the power to pursue directly or indirectly their personal interests, even with the existence of multi-level anti corruption measures. “One can always find a way to get around the restrictions of related laws and regulations”³.

There is an asymmetry in terms of market status between governments as clients and building general contractors. Powerful governmental clients could meddle in building general contractors through a range of ways. Building general contractors are in name only; in reality, they are subject to government in, say, selecting subcontractors and suppliers of material. In this case, system integrating capabilities of building general contractors are seriously impaired. One chief engineer from a building general contractor stated:

“Our job is finished when main body of building is completed, as fitment is performed by subcontractors. Some subcontractors have strong ties with governmental clients. If they are not qualified to do the job, it is difficult for us to manage them. As a matter of fact, they are paid by the clients, thus we cannot punish them. However, according to the regulations, it is we who pay them ...”

The same thing can be said by government clients in an opposite direction, “when the project goes wrong because of the corruption of the general building contractor, the management team of the government client will also get the blame”.⁴

Governments as regulators

The influence of governments as regulators includes two aspects. First, there are too many government regulatory departments, which have direct and indirect power over building general

contractors. These include industry-specific administration departments and also administrative bodies from different industries providing funding. At the ministry level, apart from MOHURD, there are also the National Development and Reform Commission (NDRC), which is responsible for preparing long term investment plans; the Ministry of Railway (MOR); Ministry of Transport (MOT); the Ministry of Electrical Power (MOEP) and so forth. The vertical structure of the regulatory system in the construction industry further comprises the Department of Housing and Urban-Rural Development (DOHURD) at province, autonomous region and municipality levels; the Commission of Construction at county level, and so on, as shown in the third column in Table 1. A popular expression used to describe this situation is: “*Twenty eight big forage caps manage one safety helmet*”.⁵

In practice, a building general contractor cannot even select subcontractors freely. As one general manager from a construction enterprise put it:

“There are various regulatory bodies exercising their enforcement power, twenty eight big forage caps manage one safety helmet. Such as Civil Air Defense, Fire Department, Broadcast and Television, etc. These twenty eight big forage caps enforce the separation of the projects to pursue their own interests...ultimately even doors and windows of a construction project have to be parcelled out.”⁶

Table 1. Different roles played by different government departments

Governments’ roles	Governments as clients	Governments as regulators	Governments as administrators of professional bodies
Government departments	All government departments	Central level: MOHURD, NDRC, MOR, MOT, MOEP, etc. Local level: Civil Air Defense, Fire Department, Broadcast and Television, etc.	MCA, MOHURD, China Association for Science and Technology, etc.

Secondly high uncertainty, resulting from so many regulatory bodies being involved in approval processes for adopting new technologies, saps firms’ motivation to innovate. The effect of construction projects on safety in terms of lives and property has been all too evident in a number of

highly publicised recent accidents, leading regulatory authorities to tighten their supervisory procedures. In 2005, the MOHURD issued *Detailed Regulations on Adopting New Technology, Process and Material which are not in accordance with Construction Engineering Compelling Stand*. The procedure is called “Three New Approvals (TNA)”. The MOHURD is responsible for the uniform administration, while the Standard Quota Department directly under the MOHURD implements the approval process.

Under the TNA regime applications for adopting new technologies become even more difficult. First, the TNA process is very complex. The firms applying for TNA have to offer: (i) evaluation documents at provincial, ministry or national level; (ii) reports on application to domestic or foreign engineering projects, or reports on tests or pilot production; (iii) approvals of standard administrative department under State Council or construction administration authorities at provincial, autonomous region and municipality level; and (iv) organize expert groups to participate in the meetings of technology investigations and provide a summary of the meeting. The more complex the TNA process, the more uncertain this process is.

Second, the TNA also probably increases the time taken for approvals. Despite Article 18 of the detailed regulations stipulating: “The Standard Quota Department directly under the MOHURD should make decision on the TNA in twenty days. If the situation is too complex to make a decision, the deadline could be extended ten days. In this case, the department must compile a “*Construction Administration Postponed Note*” and send it to the applicant, and explain the reason for the postponement. However, this is not the case in practice. As a manager of a construction firm put it: “It has been one year since we submitted the new technology application, but we have not yet received any news.”⁷

Finally, when conducting the TNA, the government not only considers the applicable potential of new technology, process and material, but also other issues such as employment and social stability resulting from new technologies deployed. Where closures, unemployment and social instability might ensue in such a labour-intensive industry, the concerning government department is likely to

reject applications or pass them up for higher level approval. All these with numerous segregated regulators, each in charge of different matters, make it almost impossible to adopt anything new whatever: technologies, processes and/or materials.

Governments as administrators of professional bodies

Since the economic reforms, professional bodies and industry associations have been mushrooming in China. Industry associations in construction at national level include the Construction Industry Association of China; the Survey and Design Association of China; the Construction Supervision Association of China; the Installation Association of China; the Civil Engineering Association of China; the Construction Fitment Association of China, etc. Professional bodies include the Architecture Society of China and the Civil Engineering Society of China. Generally speaking, professional bodies at local level mirror those at national level. In Zhejiang province, for instance, there is the Construction Industry Association of Zhejiang; the Installation Industry Association of Zhejiang; the Survey and Design Association of Zhejiang; the Civil Engineering Association of Zhejiang; the Construction Supervision Association of Zhejiang; and the Construction Fitment Association of Zhejiang, etc. Compared to the functions mentioned by Miller et al. (1995) and Winch (1998), most these organisations have functions, such as channelling information and knowledge flow within their networks, maintaining integrity of their profession. They provide technological and professional ethical training to their members, organise knowledge and information exchanges including seminars and overseas visits. Most importantly, one way or another, they all have a close link with the government, which could be the industrial government departments and the government S and T divisions at national and local levels.

A professional body in China is officially categorised as a social organisation (*shehui zuzhi he tuanti* in Chinese). A social organisation refers to a non-profit organization formed by willing members sharing common wishes, and operates according to its rules. The Construction Industry Association of China, for example, is a non-profit social organisation having the status of an

independent legal entity. It is a nationwide trade organization made up of professionals from the areas of civil engineering; construction engineering; pipe equipment installation and construction fitment. The Civil Engineering Society of China is another such social organisation.

Currently the way in which social organisations are managed is called “Double administration regime at various level” (Yu, 2006). Various-level-administrations refer to managing social organisations in accordance with their levels. Double administration means social organisations need to seek an operation administration authority to examine its qualification before it is registered. Afterwards, the registration authority is responsible for supervision and discipline; and the operation administration authority is responsible for daily operation guidance. For example, the operation administration authority of construction industry association is the MOHURD, its registration authority is the Ministry of Civil Affairs (MCA).

Although industrial associations are supposed to be independent entities (see Miller et al. 1995, Winch 1998 and Winch and Coutney 2007), in China, governments can exert substantial influence over their operations. The industry associations can be divided into two types: *official-push industry associations* and *folk-spontaneous industry associations* (Chen and Xu 1999). While there are many differences between these two types, they share a same feature being heavily reliant on governments.

With regard to official-push industry associations, first, governments have excessive control over the personnel of industry associations. Many presidents and general secretaries of industry associations are appointed by government, either retired officials, or part-time leaders of large state-owned firms. Second, a majority of the industry associations are institutionally and physically connected with their supervisory government bodies. A survey of 84 industry associations in Jiangsu province (Jiang 2006) shows about half of the office spaces of industry associations are part of the building of their operation supervision authorities. Finally, most of the industry associations are financed by governments. As a result, these industry associations, while enjoy the financial benefits, at the same time do not have much operational independence from the

government, becoming quasi-government official organisations. Long-term parasitism provides little incentive for them to operate beyond more myopic local government concerns, making them averse to serving and representing the industry's own interests to the fullest extent.

As for the second type, folk-spontaneous, industry associations, most of them will move eventually on to the first category by seeking for the official connection with an administration/supervisory authority, a government organisation. If they are unable to establish such a link, it will be difficult for them to register officially having a status of an independent legal entity but to be classified as “illegal organizations”.

In practice, the Chinese government can have multiple ways to influence professional bodies and industrial association, through controlling top personnel and financing them, the most powerful strings attached to an organisation. Even though no direct control is pursued by the government, these organisations may naturally look at the government for directions. Moreover, the “government” is practically of fragmented individual entities, each has its own interests and priorities at different time-space and circumstances.

Following our discussion above, we can see that the Chinese government has an over-whelming power influencing the key players of innovation superstructure in the construction industry. The causal map (see Figure 7) reveals the underlying issues and the impacts of the government on innovation in the sector. As clients, the government could use its power of selecting both design and building contractors to force the effective negotiation and integration of two separate systems, therefore promoting uptake of new technologies and ideas. Acting as the regulator, the government has the sole power to drive the innovation, such as using greener materials, effective equipments, efficient managerial methods, etc. to achieve ultimate goals for sustainable development. Because of the historical and socialist legacy of the social - economic institutional settings in China, the government could effectively leverage innovation through administrative and financial means and by supporting industrial and professional bodies and encouraging them to act as knowledge brokers across the boundary of architect design and construction operations.

Our research also points out that in reality, government clients are not a single client, nor has a uniform set of demands in mind when selecting individual design and building contractors. In the construction industry, there are just too many governmental organisations at various levels having a role as regulator. In addition to this, the approval process for introducing new technologies and ideas, layer after layer, leads to substantial delays in the procedure, inhibiting innovation. The competing objectives underlying decisions by these government regulators, such as between economic efficiency and social stability, make things even more complex. These elements have perhaps been the main determinants in the Chinese construction industry, which slows down technological progress.

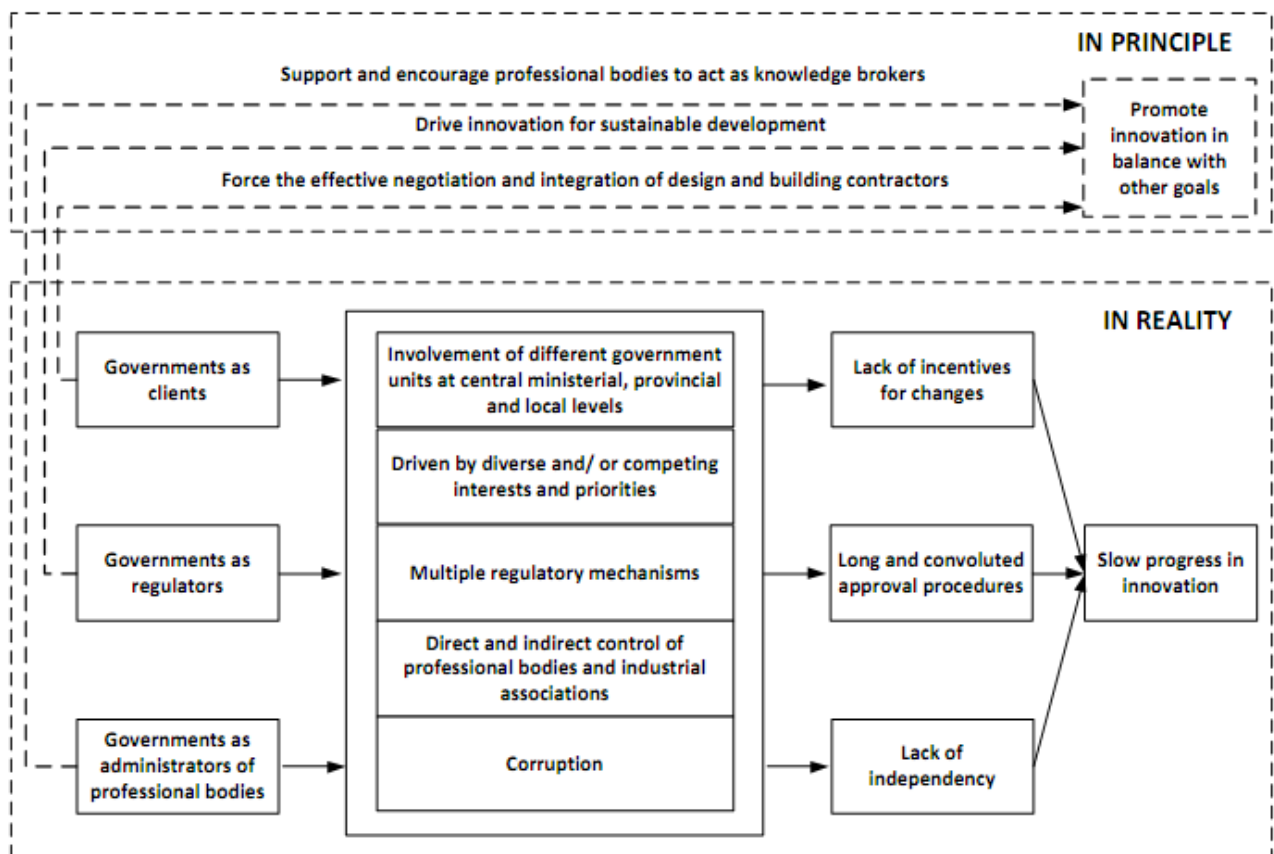


Figure 7. Government influences in Chinese construction industry: A causal map

Conclusion

During the last two decades, China's construction industry has boomed, yet technology progress has been paradoxically slow. Our research demonstrates that the Chinese construction industry can

be best seen as a complex systems industry, and the analysis of project oriented innovations by applying the models consisting of “innovation superstructure” and “infrastructural structure” developed by Miller et al. (1995) and Winch (1998) is useful in unravelling underlying issues and the impacts of governments.

This paper shows the “government” has overarching power over the “innovation superstructure” and can directly and indirectly leverage innovation in the sector by playing roles as clients, regulators and administrators of industrial associations and professional bodies. This is in line with existing literature findings that governments can play an extremely important role in innovation, in particular in an emerging market like China where the transition from a central planned system to a market economy has left various gaps and loopholes in the operations of the social and economic mechanisms of the country. Albeit, the construction case study reminds us of the likelihood of negative impacts on innovation because of the competing objectives the government may have, as well as the different vested interests of individual governmental organisations at various levels and at a specific time and in particular circumstances. It also has to take into account the impact of possible corruption of individual government officials and the institutional structure that may bestow powers on their positions.

Drawing on our research findings, we see the generic complex issues involved in the construction industry. A government as a regulator needs to strike the balance between economic growth and social sustainable development, social welfare, safety of the public or greener environment, and so forth. In dealing with the complex matters involved, how to improve the efficiency of regulatory mechanisms and procedures is a pressing issue for any government. In China, further research is needed to identify the problems involved in making comprehensive rulings in an efficient manner because of the institutional structures and competing interests amongst different governmental organisations.

Referring back to Winch and Courtney’s suggestion (2007) to establish an innovation broker in the construction sector, the paper sees the logic of a “public and private partnership” organisation

which is non-profit making and can act in promoting new technology and ideas. This may work well in the Chinese construction sector only if these organisations become truly independent in practice.

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¹ According to China Statistical Year Book, 2008, during 1995-2007, construction and installation accounts for about 60-65% of the total fixed capital investment.

² Because there are also other ownership types, the sum of state owned and private fixed capital investment is less than 100%.

³ From our interview sources.

⁴ Ibid.

⁵ Big forage caps means government officials or policemen in the Chinese context.

⁶ The interview with a building general contractor was carried out on July 10, 2009.

⁷ Our workshop minutes May 2007.